Strategic Value Analysis Integration of Renewables

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- DPC Team
  - Anthony Engineering
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- Technology Systems Division
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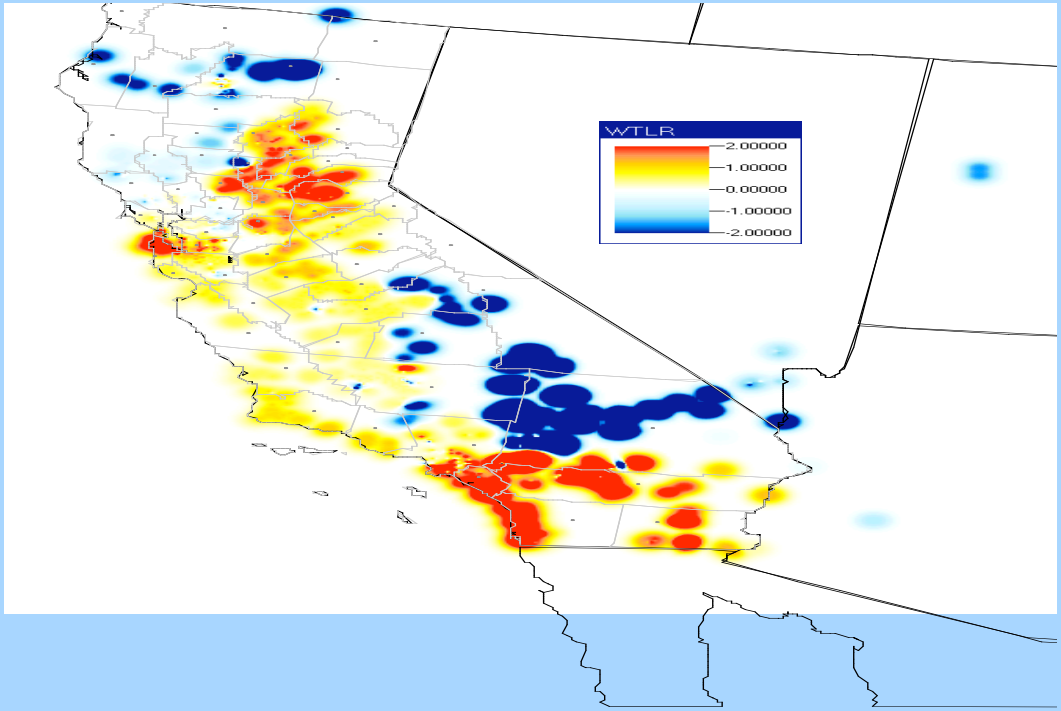
- Fire and Resource Assessment of the California Department of Forestry

Strategic Value Assessment

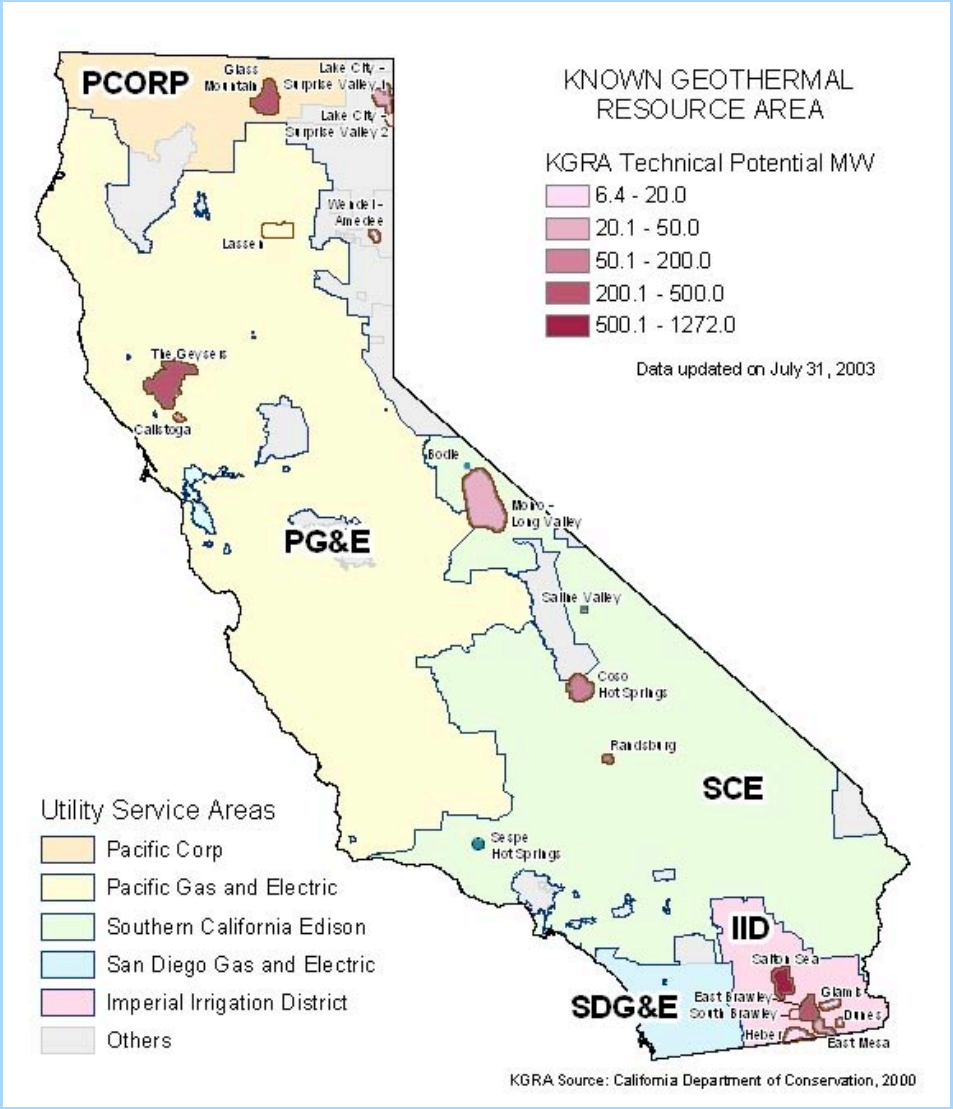
- SVA Methodology
  - Assess renewable technology resource potential for meeting RPS goals
  - Identify key focus areas for additional studies
  - Evaluate economics and timeframe
  - Evaluate points of interconnection
  - Consider solutions with environmental, economic and non-energy benefits
  - Provide solutions that can defer transmission upgrades and reduce transmission congestion
  - Prioritize renewable implementation and transmission infrastructure needs

Review of Renewable Technology Locations

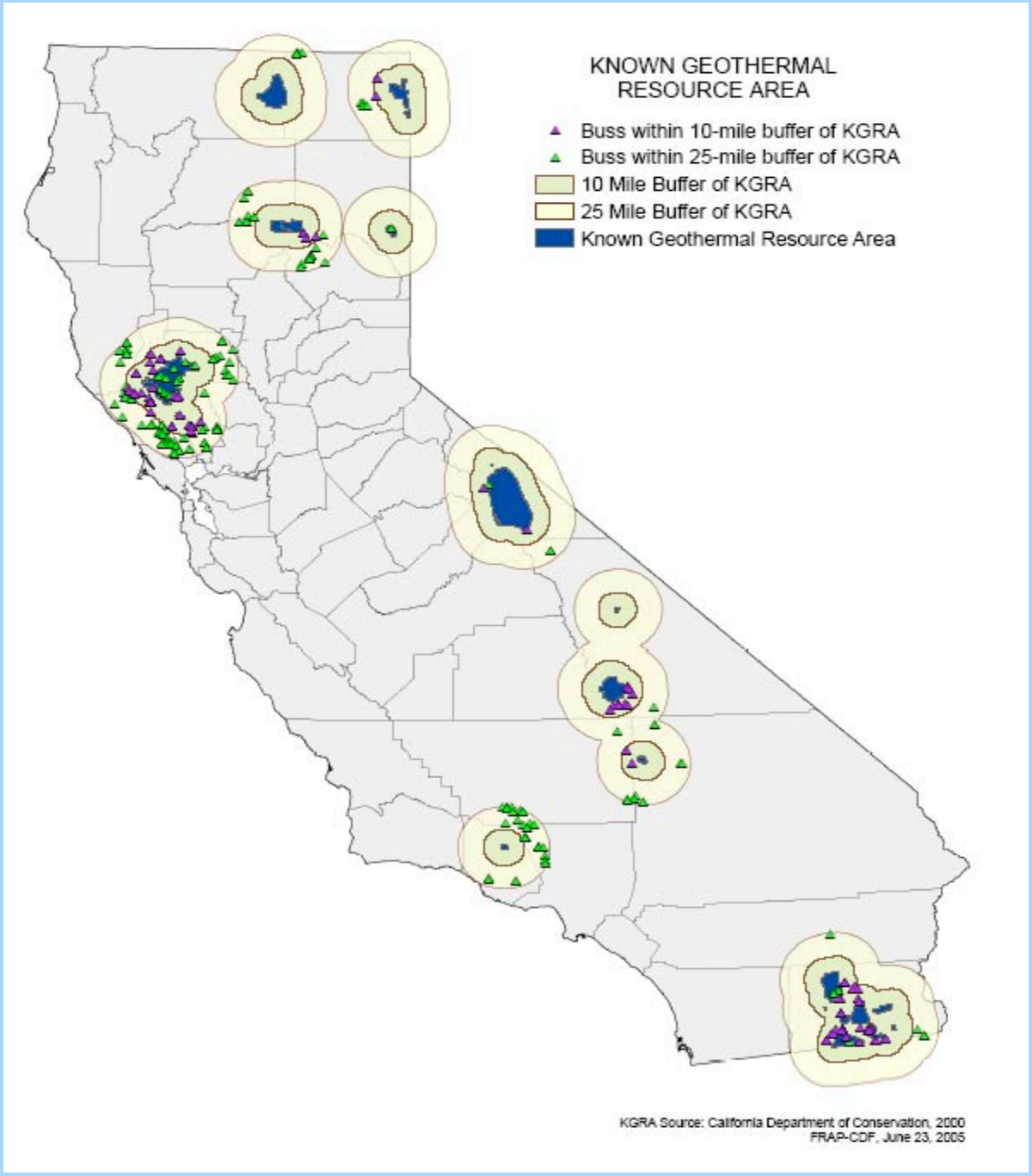
2017 Projected WTLR Locations



Geothermal Technical Potential

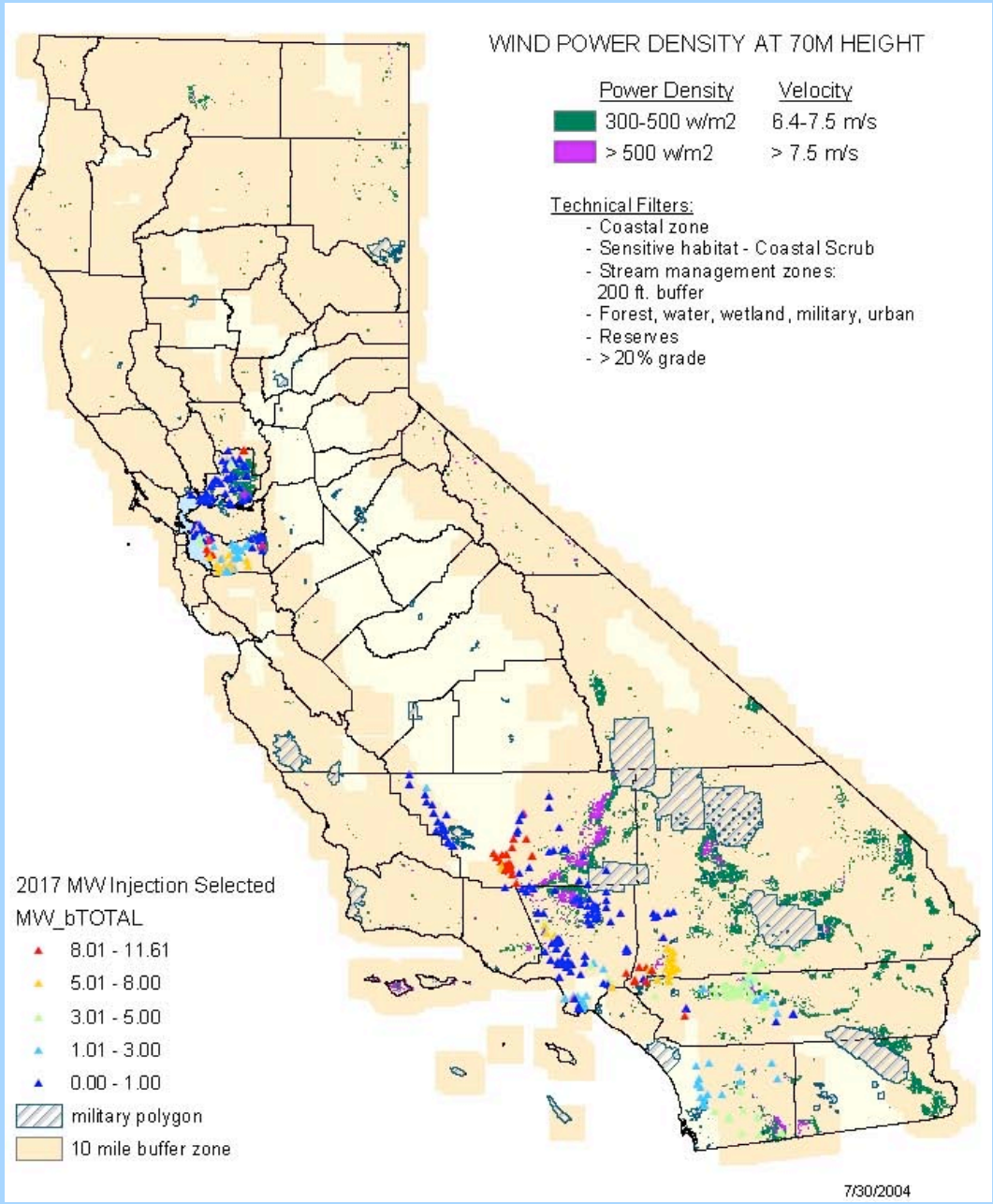


Statewide technical potential over 3800 MW


KNOWN GEOTHERMAL
RESOURCE AREA
Buss within 10-mile buffer of KGRA
Buss within 25-mile buffer of KGRA
10 Mile Buffer of KGRA
25 Mile Buffer of KGRA
Known Geothermal Resource Area
KGRA Source: California Department of Conservation, 2000
FRAP-CDF, June 23, 2005

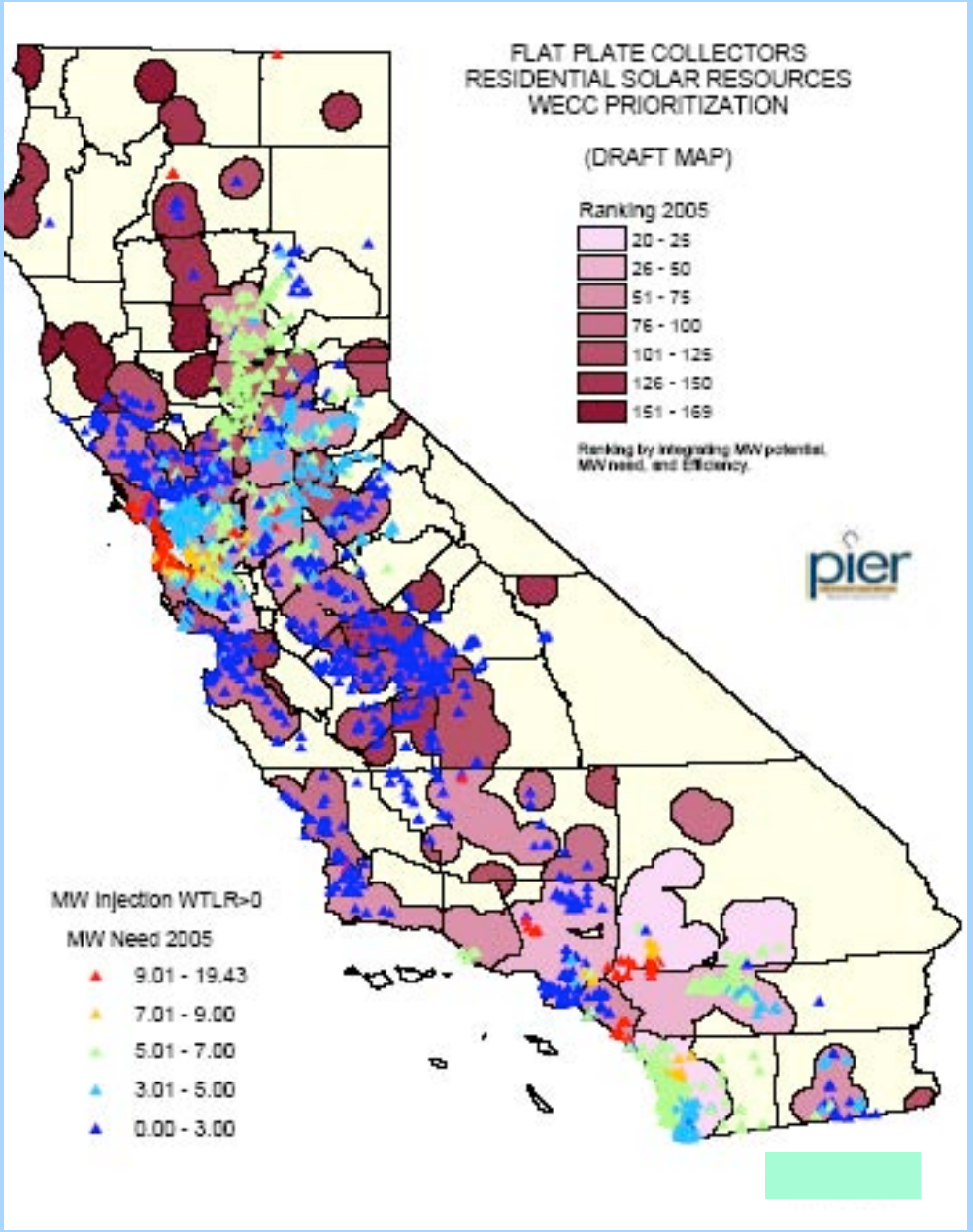
Example:

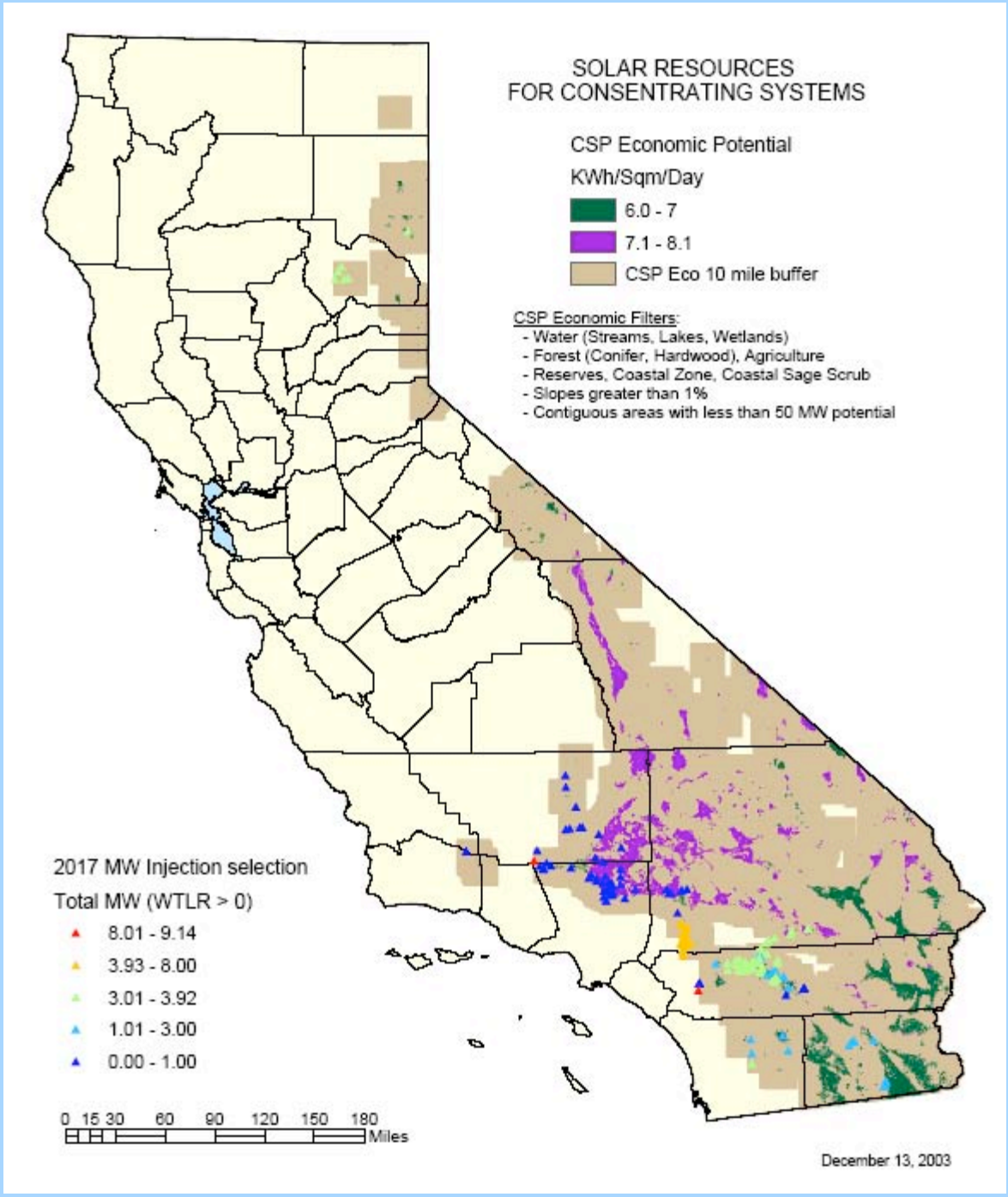
Potential wind energy injection locations based on resource availability and benefit to grid



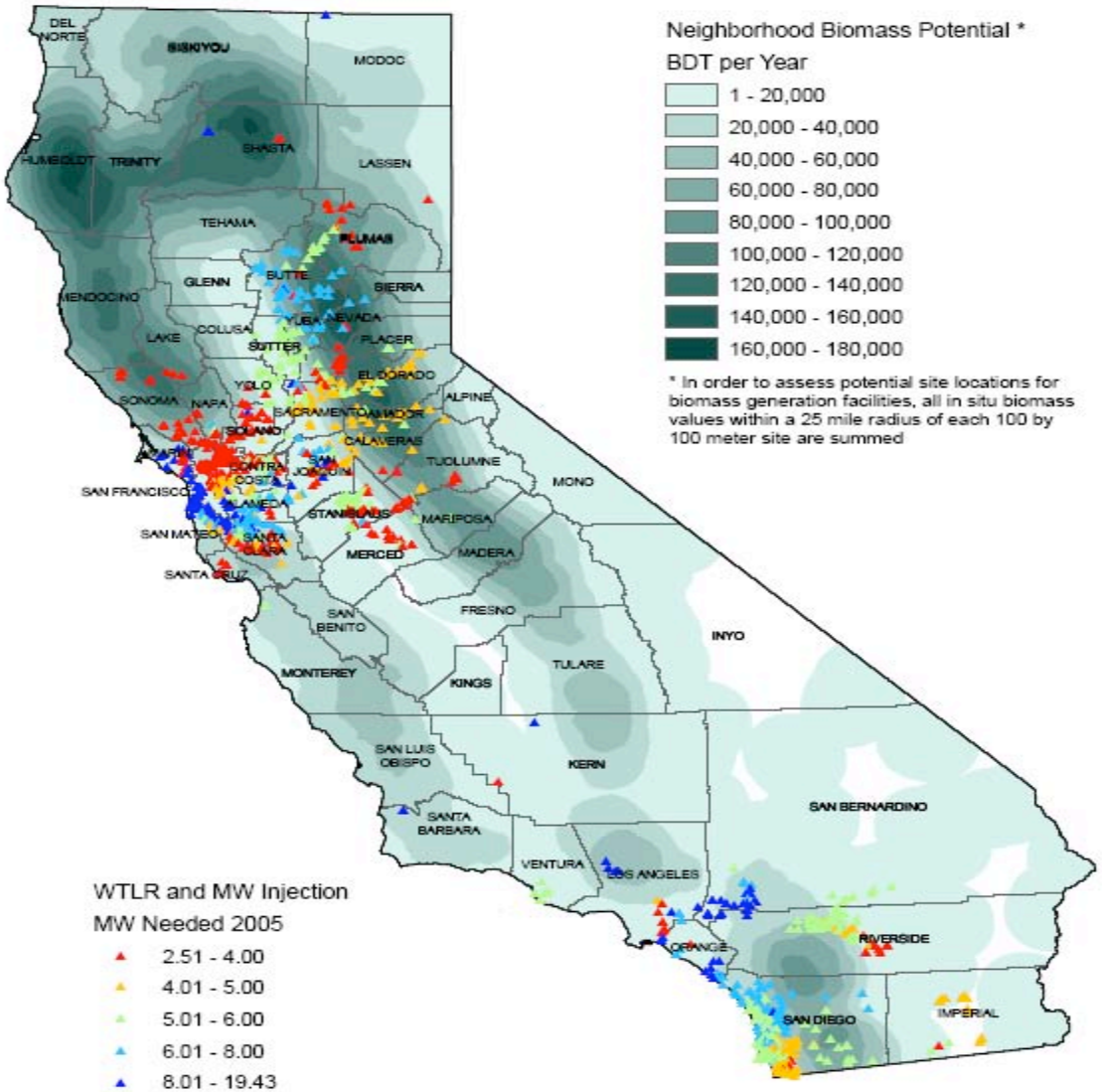
Example:

Potential solar energy injection locations based on resource availability and benefit to grid

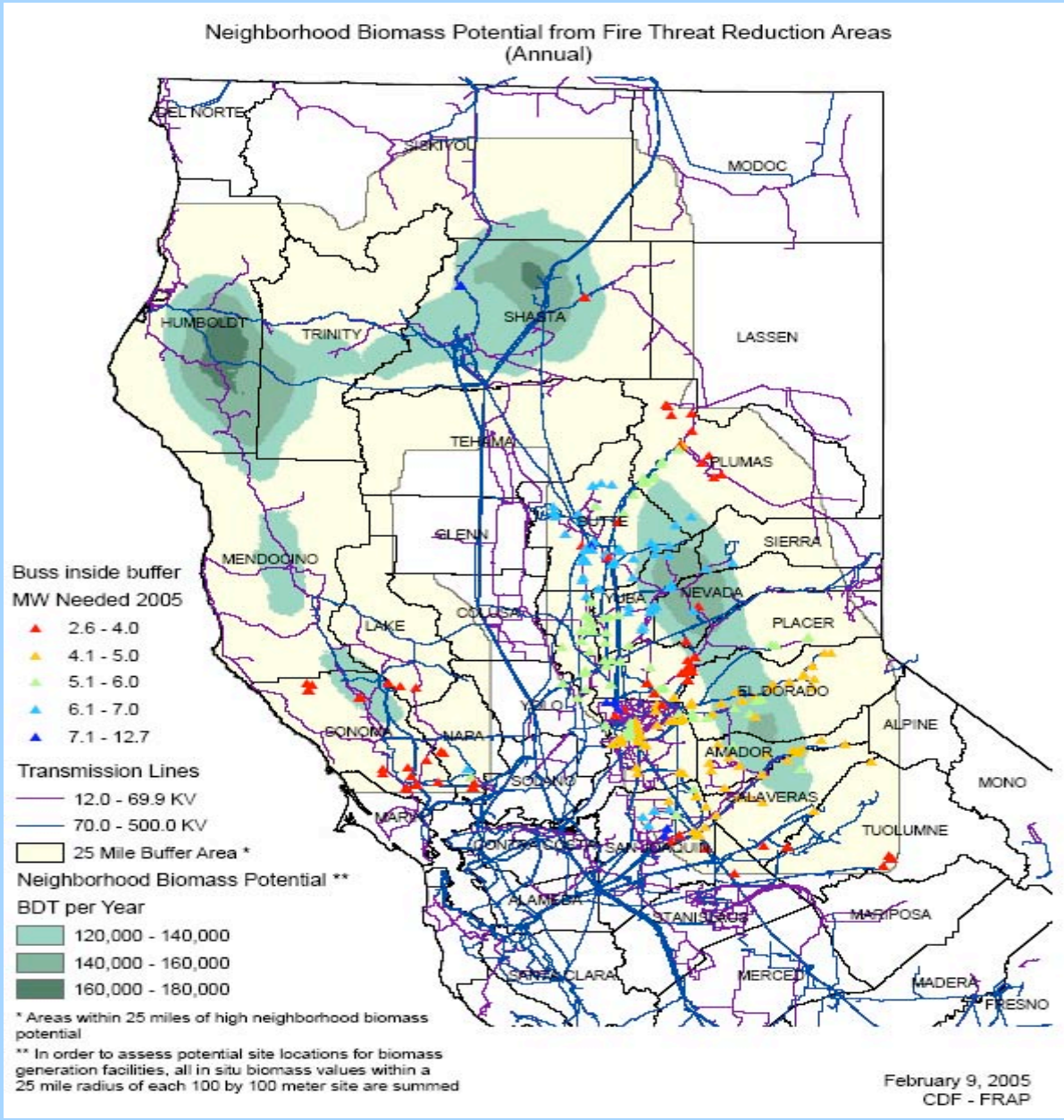


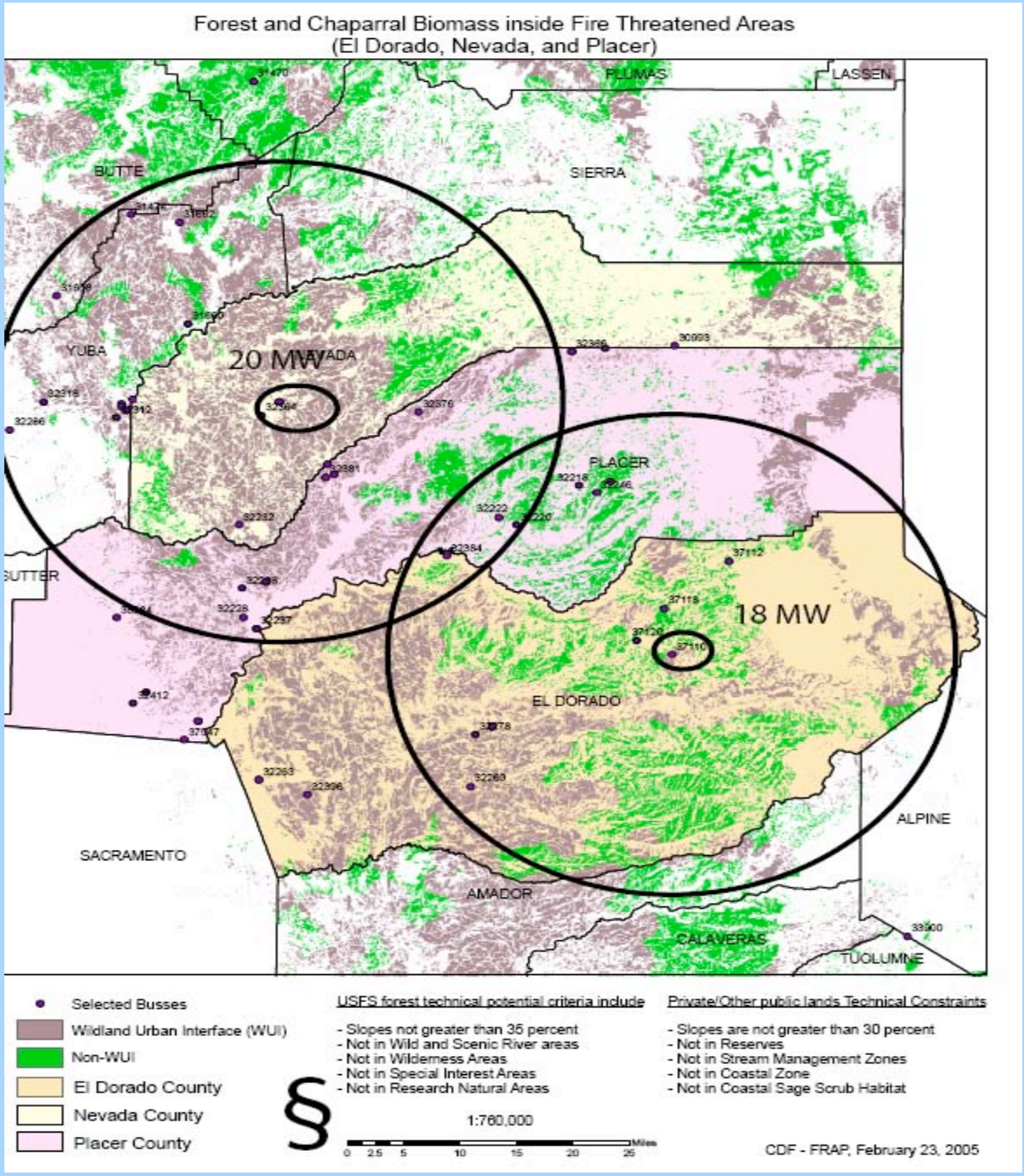

SOLAR RESOURCES
FOR CONSENTRATING SYSTEMS
CSP Economic Potential
KWh/Sqm/Day
6.0 - 7
7.1 - 8.1
CSP Eco 10 mile buffer
CSP Economic Filters:
- Water (Streams, Lakes, Wetlands)
- Forest (Conifer, Hardwood), Agriculture
- Reserves, Coastal Zone, Coastal Sage Scrub
- Slopes greater than 1%
- Contiguous areas with less than 50 MW potential
2017 MW Injection selection
Total MW (WTLR > 0)
8.01 - 9.14
3.93 - 8.00
3.01 - 3.92
1.01 - 3.00
0.00 - 1.00
0 15 30 60 90 120 150 180
Miles
December 13, 2003

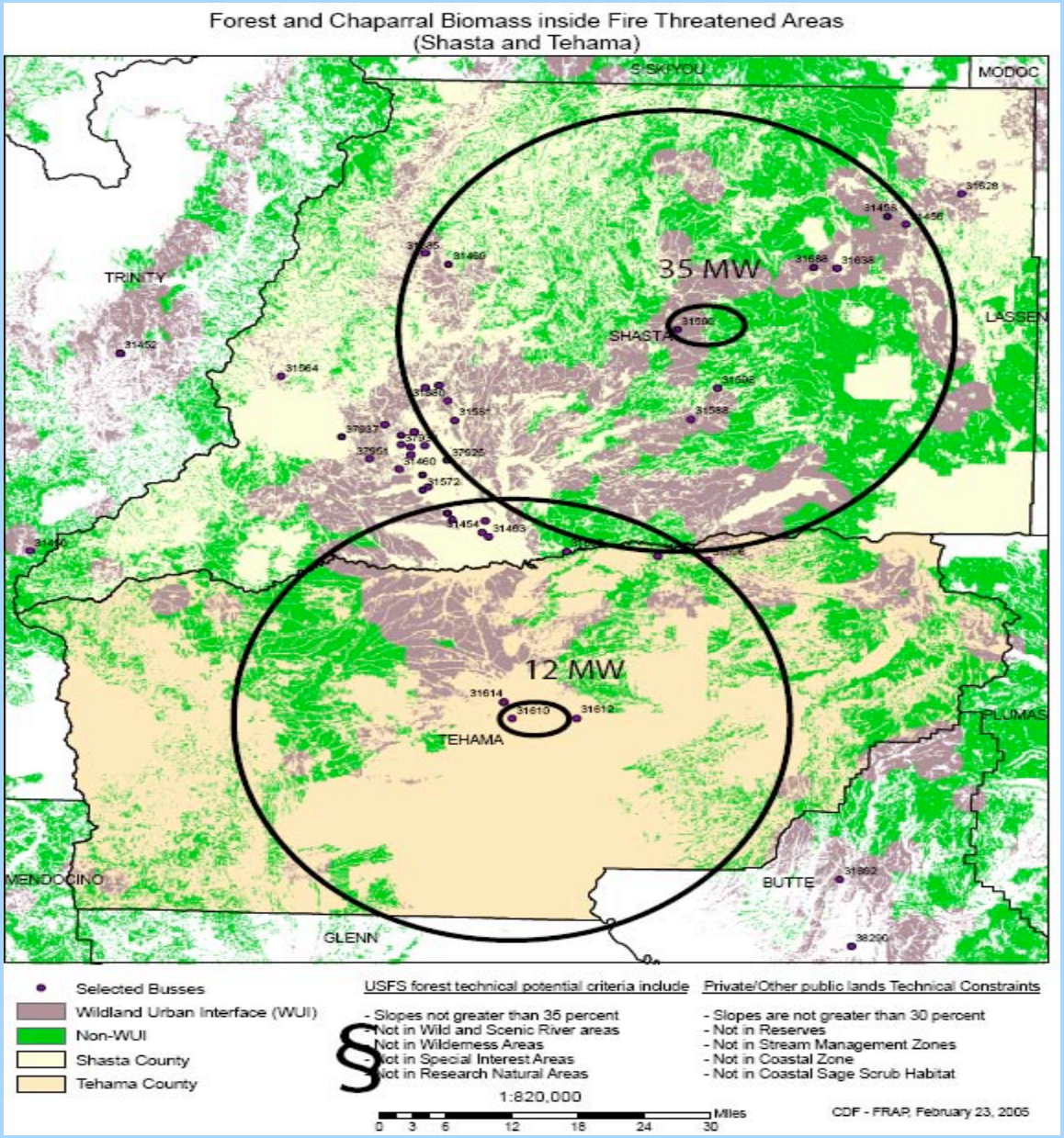
Neighborhood Biomass Potential from Fire Threat Reduction Areas (Annual)



February 9, 2005
CDF - FRAP

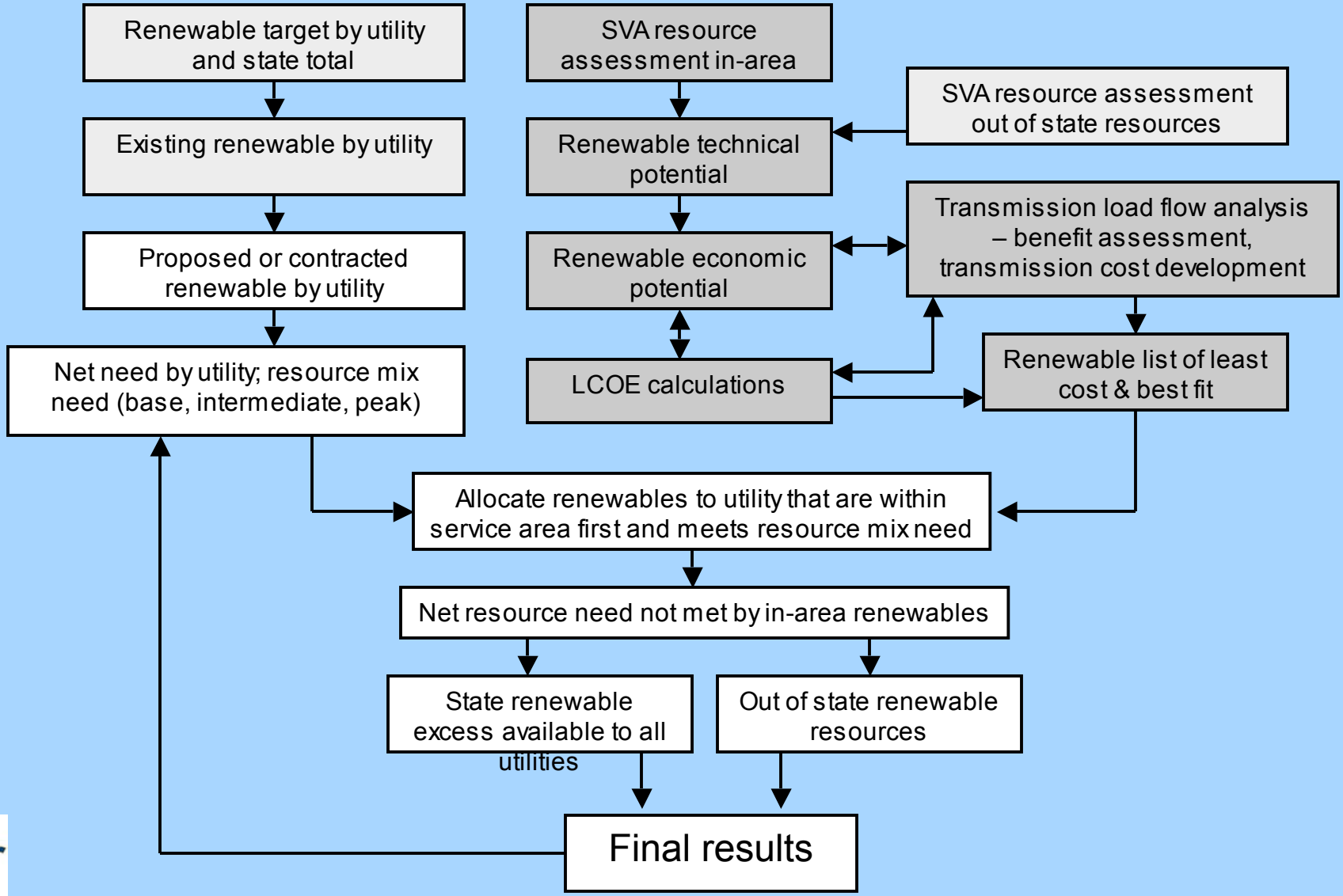

Neighborhood Biomass Potential from Fire Threat Reduction Areas
(Annual)
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
YUBA
NEVADA
COLUSA
LAKE
PLACER
EL DORADO
YOLO
SONOMA
NAPA
ALPINE
AMADOR
SOLANO
MONO
CALAVERAS
MARIN
TUOLUMNE
ALAMEDA
STANISLAUS
MARIPOSA
SANTA CLARA
MERCED
MADERA
FRESNO
Buss inside buffer
MW Needed 2005
2.6 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0
7.1 - 12.7
Transmission Lines
12.0 - 69.9 KV
70.0 - 500.0 KV
25 Mile Buffer Area *
Neighborhood Biomass Potential **
BDT per Year
120,000 - 140,000
140,000 - 160,000
160,000 - 180,000
* Areas within 25 miles of high neighborhood biomass potential
** In order to assess potential site locations for biomass generation facilities, all in situ biomass values within a 25 mile radius of each 100 by 100 meter site are summed
February 9, 2005
CDF - FRAP


Forest and Chaparral Biomass inside Fire Threatened Areas
(El Dorado, Nevada, and Placer)
PLUMAS
LASSEN
BUTTE
SIERRA
YUBA
20 MW
PLACER
18 MW
EL DORADO
SACRAMENTO
AMADOR
ALPINE
CALAVERAS
TUOLUMNE
Selected Busses
Wildland Urban Interface (WUI)
Non-WUI
El Dorado County
Nevada County
Placer County
USFS forest technical potential criteria include
- Slopes not greater than 35 percent
- Not in Wild and Scenic River areas
- Not in Wilderness Areas
- Not in Special Interest Areas
- Not in Research Natural Areas
Private/Other public lands Technical Constraints
- Slopes are not greater than 30 percent
- Not in Reserves
- Not in Stream Management Zones
- Not in Coastal Zone
- Not in Coastal Sage Scrub Habitat
1:760,000
0 2.5 5 10 15 20 25 Miles
CDF - FRAP, February 23, 2005


Forest and Chaparral Biomass inside Fire Threatened Areas
(Shasta and Tehama)
SISKIYOU
MODOC
TRINITY
SHASTA
LASSEN
35 MW
12 MW
TEHAMA
PLUMAS
BUTTE
GLENN
MENDOCINO
Selected Busses
Wildland Urban Interface (WUI)
Non-WUI
Shasta County
Tehama County
USFS forest technical potential criteria include
- Slopes not greater than 35 percent
- Not in Wild and Scenic River areas
- Not in Wilderness Areas
- Not in Special Interest Areas
- Not in Research Natural Areas
Private/Other public lands Technical Constraints
- Slopes are not greater than 30 percent
- Not in Reserves
- Not in Stream Management Zones
- Not in Coastal Zone
- Not in Coastal Sage Scrub Habitat
1:820,000
0 3 6 12 18 24 30 Miles
CDF - FRAP, February 23, 2005

SVA Methodology

SVA Methodology Flow Chart



Prioritizing Renewables

- Target renewable technologies
  - Geothermal
  - Biomass (forestry, landfill gas, urban gas, dairy manure
  - Wind (high wind, low wind
  - Solar (CSPSolar, residential)
- From an extensive list of renewable technologies, sorting can be accomplished by:
  - Utility
  - Renewable type
  - Transmission impact ratio
  - LCOE
    - With and without PTC

20% Penetration Requirement

LSE	2001 estimated renewable baseline (GWh/yr)	2003 actual (GWh/yr) {% of 2003 APT}	2004 actual (GWh/yr) {% of 2004 APT}	2005 IOU expected (GWh/yr)	2005 needed to be on course for 20% by 2010 (GWh/yr)	2010 20% of demand forecast (GWh/yr)	2017 20% of demand forecast (GWh/yr)
PG&E	6,719	8,828 {101%}	8,591 {91%}	9,087	9,633	15,879	
SCE	11,364	12,497[b] {104%}	13,246 {104%}	13,634	14,560	15,934	
SDG&E	146	550 {285%}	678 {160%}	884	1,285	3,462	
DA & Rest of state	7,587	4,853	4,676		13,132	20,885	
Total	25,816	26,728	27,191		38,610	56,160	61,114

Impact Ratio??

What is a Transmission Impact Ratio?

- An impact ratio is a relative measure of the reliability of the transmission system
- It is used to measure the relative reliability and securing differences between different interconnections of renewables, transmission lines or conventional resources
- It is used to prioritize alternatives as to their strengths to improving system reliability

Impact Ratio Cont'd

- Transmission load flow analysis is based on thermal rating of transmission equipment
- Other aspects considered in load flow analysis includes low voltage, phase angles, VAR flows and intertie flows
- Impact ratios may change under spring and winter analysis which is to be expected since flows change due to maintenance and hydro conditions
- May indicate additional transmission upgrades above those required for summer due to these flow changes

Renewable Alternatives Analyzed

2010-2017 Renewables Options

Utility	Renewable	Location	MW	2010 Impact Ratio	2010 LCOE (cents/kWh)	2010 MPR (cents/kWh)	2017 Impact Ratio	2017 LCOE (cents/kWh)	2017 CC (cents/kWh)
Imperial	CSPSolar	Imperial	66	-3.2	6.00	6.05	-3.2	6	9.15
PG&E	CSPSolar	Plumas	0	-3	6.00	6.05	-3	6	9.15
SCE	CSPSolar	Riverside	599	-3.2	6.00	6.05	-3.2	6	9.15
SCE	CSPSolar	San Bernardino	447	-1.7	6.00	6.05	-1.7	6	9.15
SDG&E	CSPSolar	San Diego	35	-1.8	6.00	6.05	-1.8	6	9.15
PG&E	High Wind	Solano County	275	-0.67	3.07	6.05	-0.67	3.07	9.15
PG&E	High Wind	Alameda County	132	-0.125	3.07	6.05	-0.125	3.07	9.15
SCE	High Wind	San Bernardino County	168	-5.3	3.07	6.05	-5.3	5.86	9.15
SCE	High Wind	Riverside County	1416	-1.4	3.07	6.05	-1.4	3.07	9.15
SCE	High Wind	Tehachapi	1200	0.008	3.07	6.05	0.008	6.13	9.15
SDG&E	High Wind	San Diego	150	-1.6	3.07	6.05	-1.6	7.13	9.15
PG&E	Low Wind	CRAGVIEW	40	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	FLTN JT2	3	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	VACA-DXN	60	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	TRAVISJT	50	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	MAINE-PR	50	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	WINDMSTR	28	-0.3	7.32	6.05	-0.3	4.02	9.15
PG&E	Low Wind	MOORPARK	50	-0.3	7.32	6.05	-0.3	4.02	9.15
State wide	Solar	Distributed	500	-2	16.76	11.9	-2	16.76	11.9

Renewables Cont'd

Utility	Renewable	Location	MW	2010 Impact Ratio	2010 LCOE (cents/kWh)	2010 MPR (cents/kWh)	2017 Impact Ratio	2017 LCOE (cents/kWh)	2017 CC (cents/kWh)
State wide	Biomass Dairy	Diary Manure	38	-4.5	3.76	6.05	-4.5	2.14	9.15
PG&E	Biomass Forestry	RDGE CBN	59	-3	6.49	6.05	-3	5.52	9.15
PG&E	Biomass Forestry	KEKAWAKA	43	-3	7.07	6.05	-3	6.08	9.15
PG&E	Biomass Forestry	HGHLNDJ2	18	-3	10.00	6.05	-3	8.95	9.15
PG&E	Biomass Forestry	WILLITS	35	-3	7.55	6.05	-3	6.55	9.15
PG&E	Biomass Forestry	MIRABEL	18	-3	10.00	6.05	-3	8.95	9.15
PG&E	Biomass Forestry	TRINITY	26	-3	8.45	6.05	-3	7.43	9.15
PG&E	Biomass Forestry	CEDR CRK	39	-3	7.28	6.05	-3	6.29	9.15
PG&E	Biomass Forestry	TYLER	11	-3	13.21	6.05	-3	12.1	9.15
PG&E	Biomass Forestry	BIG MDWS	32	-3	7.79	6.05	-3	6.79	9.15
PG&E	Biomass Forestry	GRSS VLY	40	-3	7.22	6.05	-3	6.23	9.15
PG&E	Biomass Forestry	CH.STNJT	21	-3	9.28	6.05	-3	8.24	9.15
PG&E	Biomass Forestry	JONESFRK	25	-3	8.59	6.05	-3	7.57	9.15
PG&E	Biomass Forestry	PARADISE	26	-3	8.45	6.05	-3	7.43	9.15
State wide	Biomass Landfill Gas	Landfill Gas	318	-4.5	3.23	6.05	-4.5	2.98	9.15
State wide	Biomass WWT	Wastewater Treatment	59	-4.5	4.19	6.05	-4.5	3.79	9.15
State wide	Biomass Urban fuel	Urban Fuel	497	N/A	N/A	6.05	-4.5	3.79	9.15

Renewables Cont'd

Utility	Renewable	Location	MW	2010 Impact Ratio	2010 LCOE (cents/kWh)	2010 MPR (cents/kWh)	2017 Impact Ratio	2017 LCOE (cents/kWh)	2017 CC (cents/kWh)
Imperial	Geothermal	Superstition Mountain	10	-15.83	6.48	6.05	-15.83	5.32	9.15
Imperial	Geothermal	East Mesa	75	-5.6	10.11	6.05	-5.6	8.36	9.15
Imperial	Geothermal	Heber	42	-4.55	5.53	6.05	-4.55	4.53	9.15
Imperial	Geothermal	Mount Signal	19	-4.5	5.60	6.05	-4.5	3.71	9.15
Imperial	Geothermal	Brawley North	135	-4.42	6.13	6.05	-4.42	5.51	9.15
Imperial	Geothermal	Brawley East	129	-4.42	9.32	6.05	-4.42	8.47	9.15
Imperial	Geothermal	Brawley Mesquite	62	-4.42	10.17	6.05	-4.42	9.25	9.15
Imperial	Geothermal	Dunes	11	-4.2	8.12	6.05	-4.2	6.7	9.15
Imperial	Geothermal	Niland	76	-3.97	7.38	6.05	-3.97	6.67	9.15
Imperial	Geothermal	Glamis	6	-1.02	9.76	6.05	-1.02	8.07	9.15
Imperial	Geothermal	Salton Sea	1400	-0.6	5.34	6.05	-0.6	4.78	9.15

Renewables Cont'd

Utility	Renewable	Location	MW	2010 Impact Ratio	2010 LCOE (cents/kWh)	2010 MPR (cents/kWh)	2017 Impact Ratio	2017 LCOE (cents/kWh)	2017 CC (cents/kWh)
PacifiCorp	Geothermal	Lake City/Surprise Valley Modoc County	37	-1.05	7.17	6.05	-1.05	6.48	9.15
PacifiCorp	Geothermal	Medicine Lake Telephone Flat	175	-0.48	5.39	6.05	-0.48	4.82	9.15
PacifiCorp	Geothermal	Medicine Lake Fourmile Hill	36	-0.48	6.21	6.05	-0.48	5.58	9.15
PacifiCorp	Geothermal	Honey Lake	2	0.375	5.49	6.05	0.375	4.49	9.15
PG&E	Geothermal	Sulfur Bank Field	43	-2.91	5.54	6.05	-2.91	4.96	9.15
PG&E	Geothermal	Geysers Sonoma & Lake County	400	-2.23	8.14	6.05	-2.23	7.74	9.15
PG&E	Geothermal	Calistoga Napa County	25	-1	7.86	6.05	-1	7.38	9.15
SCE	Geothermal	Long Valley Mono County	71	0.64	4.43	6.05	0.64	4	9.15
SCE	Geothermal	Coso Hot Spring Inyo County	55	5.17	7.70	6.05	5.17	6.97	9.15
SCE	Geothermal	Randsburg	48	5.35	6.08	6.05	5.35	5.47	9.15

2010 SVA Results

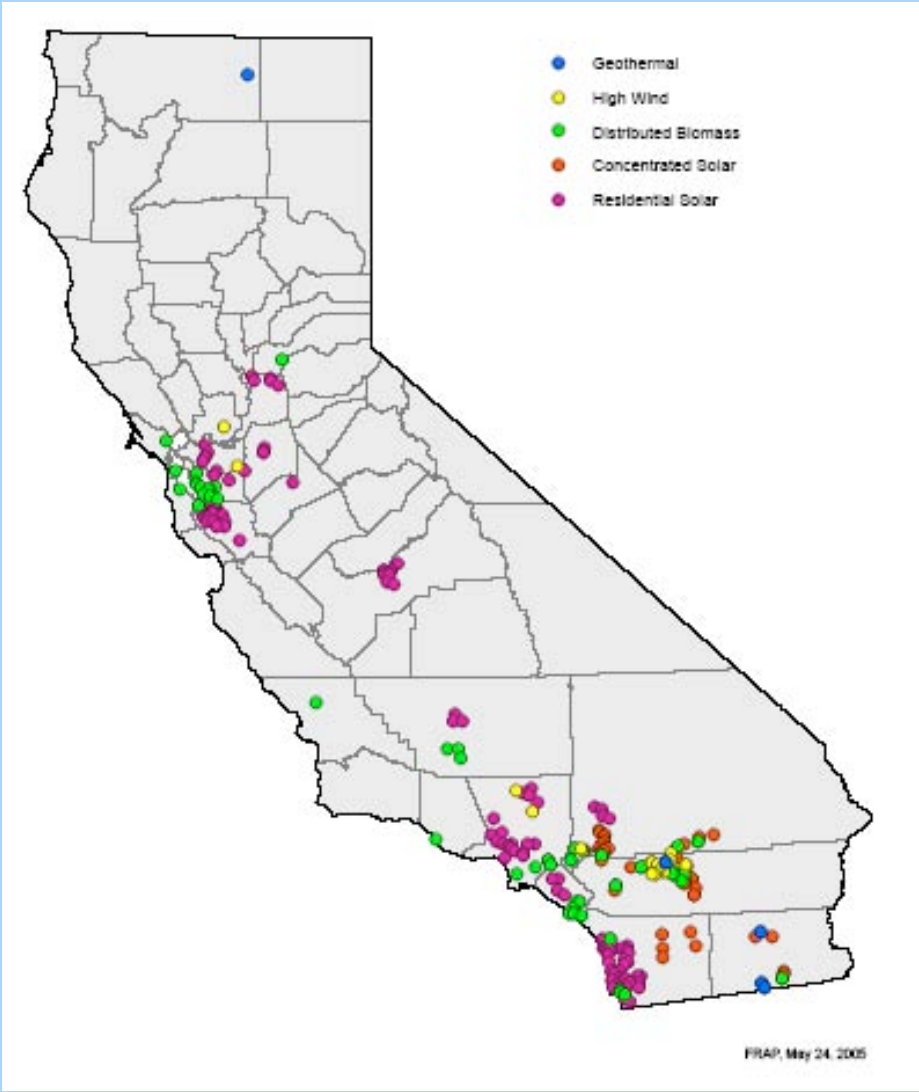
2010 Renewable Technology Mix

Location	Technology	Utility	MW	C.F. %	Energy
Salton Sea	Geothermal	Imperial	800	90.0%	6,307,200
Mount Signal	Geothermal	Imperial	19	90.0%	149,796
Heber	Geothermal	Imperial	42	90.0%	331,128
Brawley North	Geothermal	Imperial	135	90.0%	1,064,340
Sulfur Bank	Geothermal	PG&E	43	90.0%	339,012
Medicine Lake Telephone Flat	Geothermal	PacifiCorp	175	90.0%	1,379,700
Tehachapi	High Wind	SCE	900	37.0%	2,917,080
Riverside	High Wind	SCE	1,416	37.0%	4,589,539
San Bern	High Wind	SCE	168	37.0%	544,522
SDGE	High Wind	SDG&E	150	37.0%	486,180
Solano	High Wind	PG&E	275	37.0%	891,330
Altamont	High Wind	PG&E	132	37.0%	427,838
State wide	WWTP, LFGTE, Dairy	State wide	228	90.0%	1,797,552
Riverside	CSPSolar	SCE	599	27.0%	1,416,755
San Bern	CSPSolar	SCE	447	27.0%	1,057,244
State wide	Res Solar	State wide	500	20.0%	876,000
Total			6,029		24,575,216
20% Requirement					28,969,000
Net					(4,393,784)

2010 20% Penetration

- Met 85 percent of target through SVA – tried not to force penetration
- Capacity factor 46.5%
- Reasons for not meeting 100 percent penetration
  - Did not complete an exhaustive search of sites
  - Limited Tehachapi and Imperial development
  - Did not include any out-of-state renewables; no data available
  - No access to current utility contracted resources
  - Transmission construction lead times

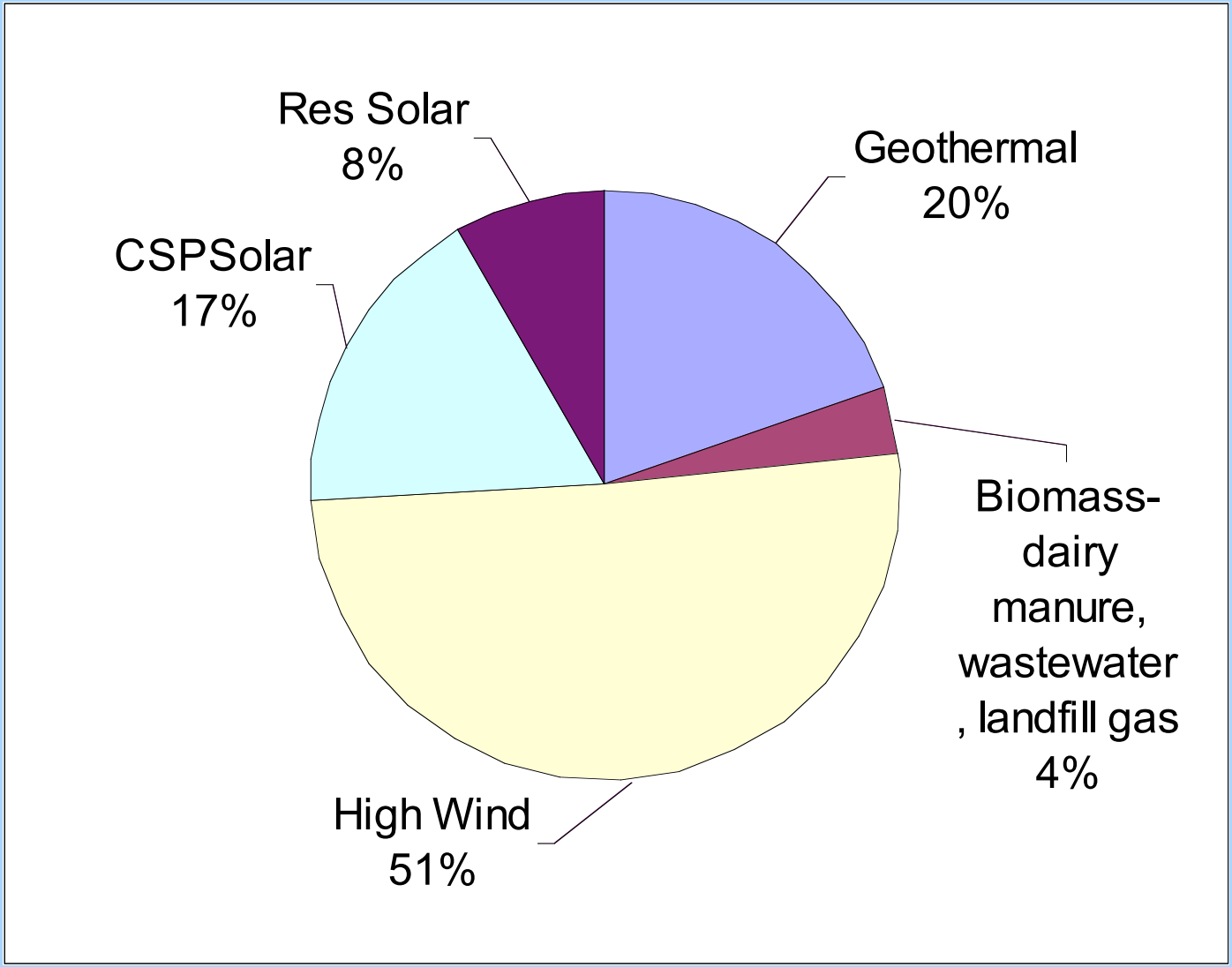
2010 Renewable Locations



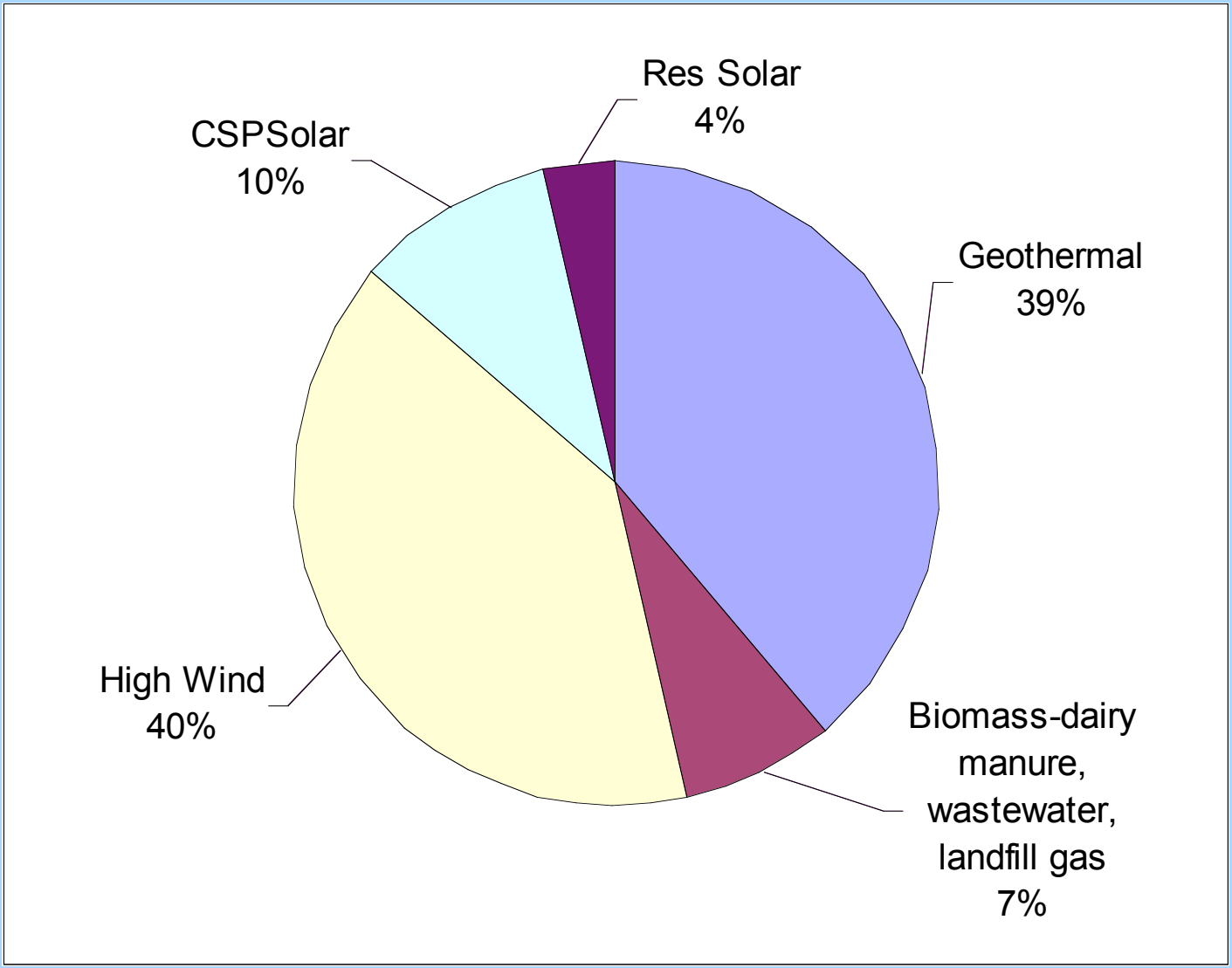
2010 Mix by Technology Type

Technology	MW	Mix %	C.F. %	Energy	Mix %
Geothermal	1,214	20%	90.0%	9,571,176	39%
Biomass-dairy manure, wastewater, landfill gas	228	4%	90.0%	1,797,552	7%
High Wind	3,041	50%	37.0%	9,856,489	40%
CSPSolar	1,046	17%	27.0%	2,473,999	10%
Res Solar	500	8%	20.0%	876,000	4%
Total	6,029	100%	46.5%	24,575,216	100%
20% Requirement			85%	28,969,000	
Net Short				(4,393,784)	

2010 Renewable Capacity Mix



2010 Renewable Energy Mix



2017 Results

2017 Incremental to Meet 20% Above 2010

Location	Technology	utility	MW	C.F. %	Energy
Salton Sea	Geothermal	Imperial	400	90.0%	3,153,600
Geysers	Geothermal	PG&E	-	90.0%	-
Niland	Geothermal	Imperial	42	90.0%	331,128
Fire Threat	Biomass	State wide	132	85.0%	982,872
State wide	WWTP, LFGTE, Dairy, Urban fuel	State wide	320	90.0%	2,522,880
Tehachapi	High Wind	SCE	300	37.0%	972,360
Contra Costa	Low Wind	PG&E	28	25.0%	61,320
Siskiyou	Low Wind	PacifiCorp	41	25.0%	89,790
Ventura	Low Wind	SCE	50	25.0%	109,500
Yolo	Low Wind	PG&E	3	25.0%	6,570
San Diego	CSPSolar	San Diego	35	27.0%	82,782
Imperial	CSPSolar	Imperial	66	27.0%	156,103
All	Res Solar	State wide	500	20.0%	876,000
Total			1,917	55.6%	9,344,905
20% Requirement					4,953,000
2010 Carryover					4,393,784
Net					(1,878)

pier

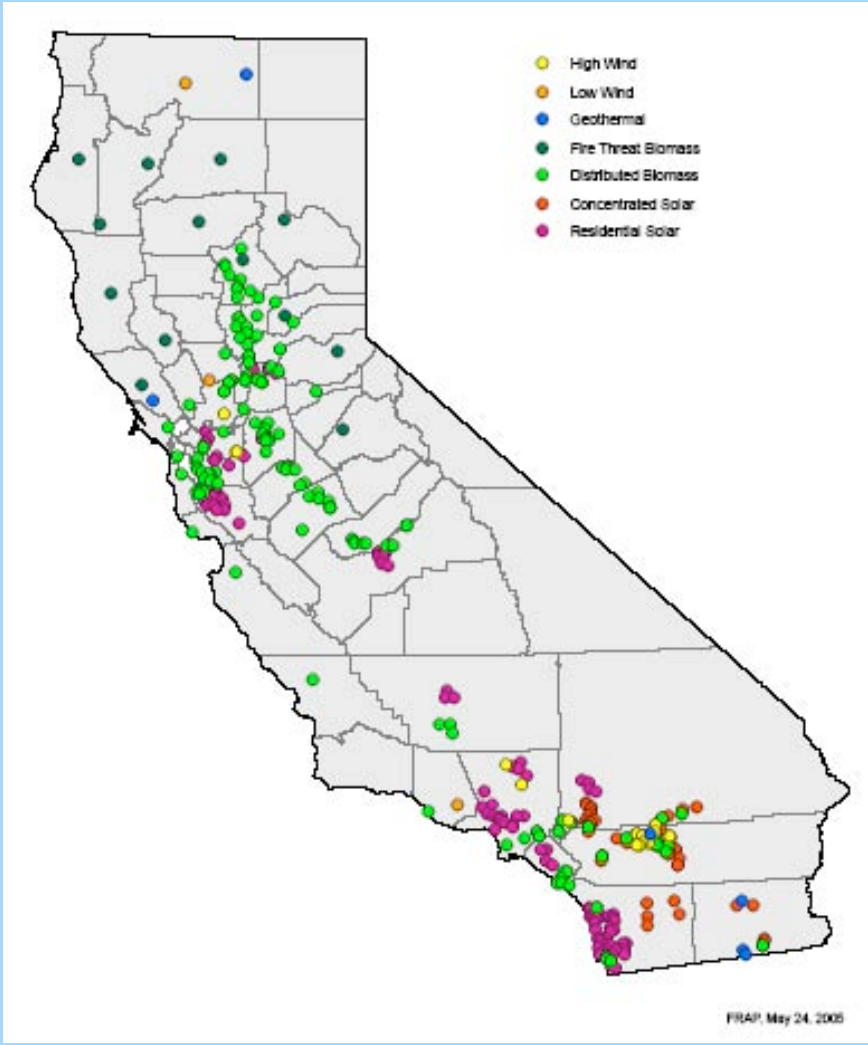
2017 20% Penetration

- Met 100 percent of target through SVA
- Easily met target without adding low wind, ultimate Tehachapi wind development, full biomass, limited solar penetration, no out-of-state resources
- Capacity factor was 55.6%
- Selection of LCOE comparison critical; lead times for transmission an issue

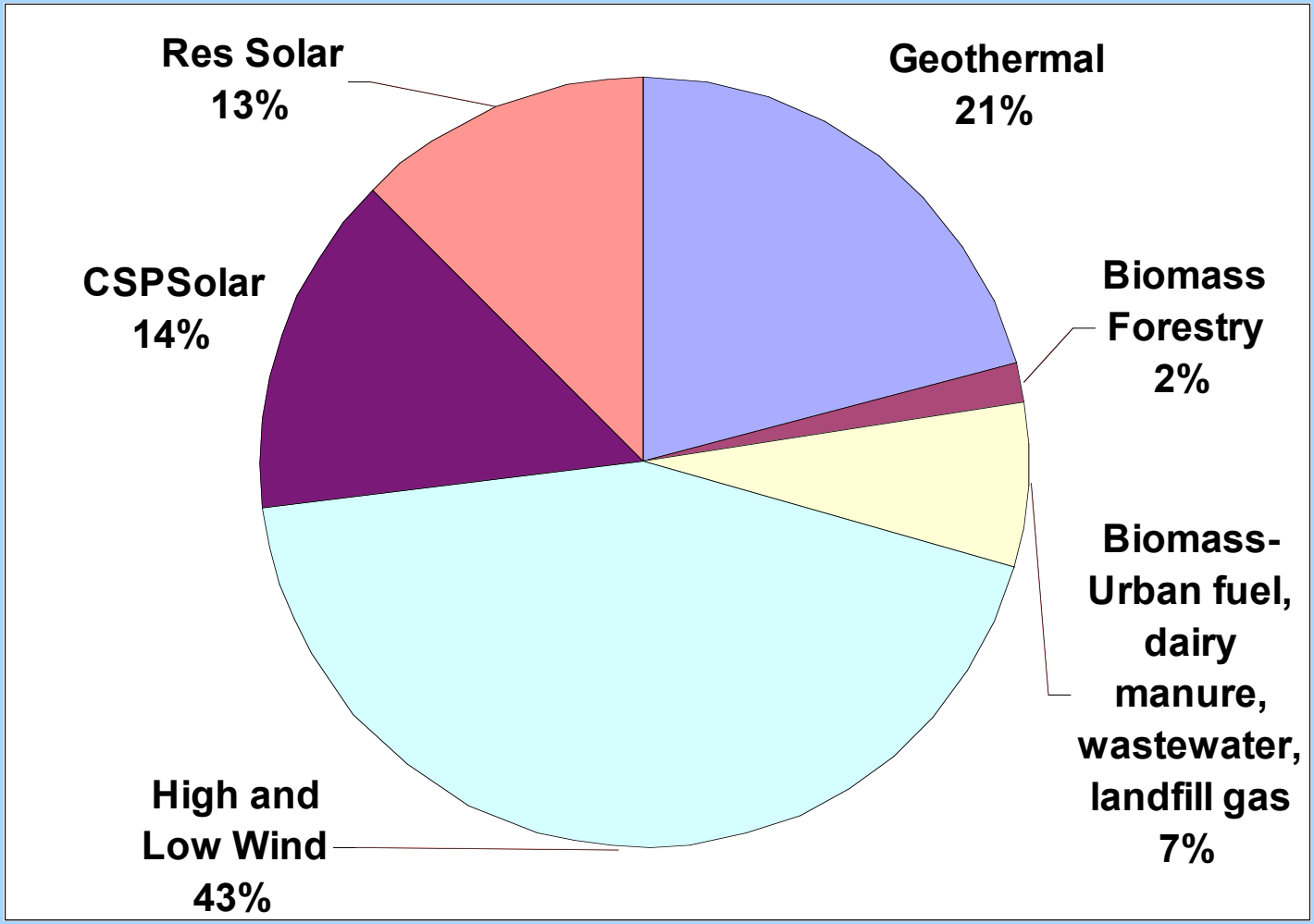
Total 2017 Composite Renewable Penetration Mix

Technology	MW	Mix %	C.F. %	Energy	Mix %
Geothermal	1,656	21%	90.0%	13,055,904	38%
Biomass Forestry	132	2%	85.0%	982,872	3%
Biomass-Urban fuel, dairy manure, wastewater, landfill gas	548	7%	90.0%	4,320,432	13%
High Wind	3,341	42%	37.0%	10,828,849	32%
Low Wind	122	2%	25.0%	267,180	1%
CSPSolar	1,147	14%	27.0%	2,712,884	8%
Res Solar	1,000	13%	20.0%	1,752,000	5%
Total	7,946	100%	48.7%	33,920,122	100%
20% Requirement				33,922,000	
Net				(1,878)	

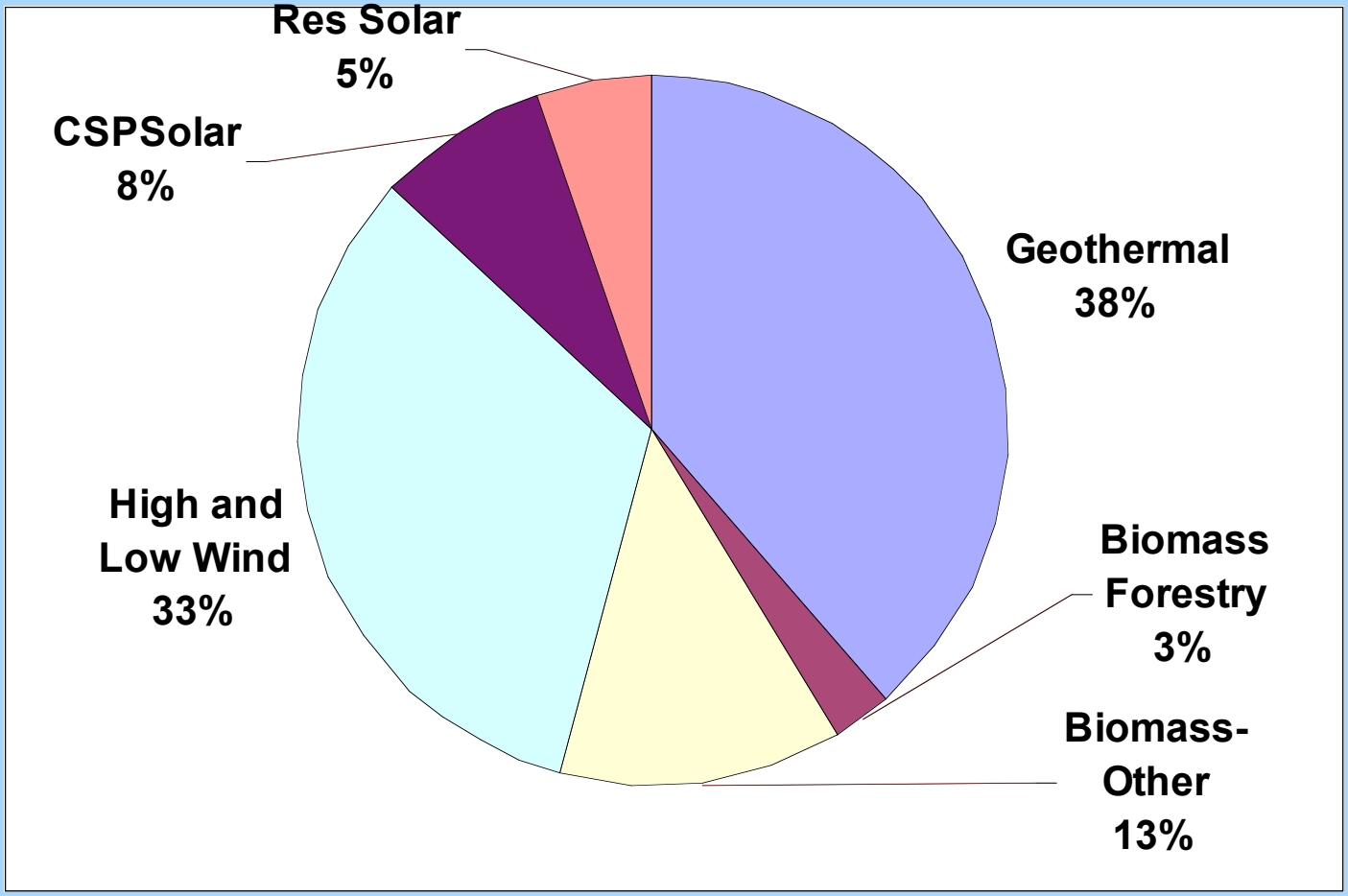
2017 Total Renewable Installed



2017 Renewable Capacity Mix



2017 Renewable Energy Mix



SVA Conclusions

- Can meet the 20% target with cost effective resources when compared to MPR and combined cycle
- Can help evaluate costs and grid impacts
- Can act as a transparent and common methodology
- Can provide helpful information to RPS process
- Can be used to compare transmission impacts between conventional and renewable sites

Recommendations

- CPUC and CEC should consider incorporating transmission benefit ratios into the RPS process
- Expand the SVA analysis to include:
  - Seasonal transmission load flow
  - Power simulation modeling
  - More user friendly software
- Obtain a test utility to further demonstrate SVA
- Expand the number of sites studied
- Study out-of-state resource options and proposed major transmission interconnections

Discussion/Questions